

Internet of Things Based Demand Side Energy Management System

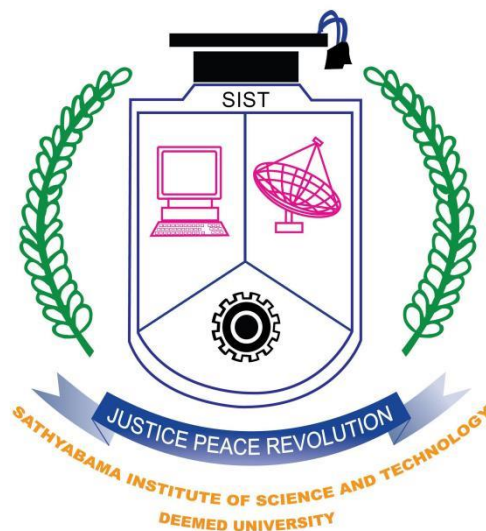
Submitted in partial fulfillment of the requirements for the award of

Bachelor of Engineering Degree in
Electrical and Electronics Engineering

by

AFASAR MYDEEN A (Register No. 37140003)

HIROK JYOTI SEN (Register No. 37140035)



**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade “A” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

APRIL 2021



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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **AFASAR MYDEEN A** (Reg.No.37140003) and **HIROK JYOTI SEN** (Reg.No. 37140035) who carried out the project entitled “**INTERNET OF THINGS BASED DEMAND SIDE ENERGY MANAGEMENT SYSTEM**” under our supervision from December 2020 to April 2021.

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External Examiner

DECLARATION

We **AFASAR MYDEEN A** (Reg.No.37140003) and **HIROK JYOTI SEN** (Reg.No.37140035) hereby declare that the Project Report entitled “**INTERNET OF THINGS BASED DEMAND SIDE ENERGY MANAGEMENT SYSTEM**” done by us under the guidance of **Mrs. M. KAVITHA** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

DATE:



PLACE:

SIGNATURE OF THE CANDIDATES

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We convey our thanks to **Dr. N. M. Nandhita., Dean, School of Electrical and Electronics Engineering** and **Dr. V. Sivachidambaranathan, Head of the Department, Dept. of Electrical and Electronics Engineering** for providing us necessary support and details at the right time during the progressive reviews.

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ABSTRACT

In most of the developing countries, the process of collecting electric meter reading and detecting illegal usage of electricity is a very difficult and time-consuming task which also requires a lot of human resources. Energy meter reading and monitoring system using the Internet of Things (IoT) provides a very efficient and cost-effective way to transfer the information of energy consumed by the consumer wirelessly as well as it provides facilities to detect the illegal usage of electricity. Aim of this study is to measure electricity consumption in the household and accordingly generate its bill automatically using IoT and telemetric communication techniques. Also, this study aims to detect and control energy theft. The PIC16f877A microcontroller is used to coordinate all the activities with a digital energy meter system and to connect the system to a Wi-Fi network and subsequently to the Internet and Server. A passive infrared sensor is engaged with the system to detect when any illegal alteration happens in the metering system. In such a case, the system will send an alert to the server as well as it has the facility to disconnect and reconnect the electricity supply automatically. The proposed system is able to continuously monitor and notify about the number of units consumed by the consumer to the energy provider as well as the consumer. The energy consumptions are calculated automatically and then the bill is updated on the internet or the web page by using a network of Internet of Things. This automation can reduce the needs of the manual labors.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

As the people have got more familiar with the digital world during the recent lockdown hence this device might turn out to be easily understandable for them as well. Most of the people are unaware of how the electricity bills are calculated even though they receive one every month. Also people are unaware of how much energy they are consuming each day, but if they get to know that then they'll definitely try to control or limit the usage of power. People having the curse of memory loss, most of the time forget to turn off the Lights & Fans, which results in a large amount of energy loss.



Fig 1.1 Energy Meter

As commercial use of electric energy spread in the 1880s, it became very important that an electric energy meter, similar to the then existing gas meters, has to be implemented to properly bill customers for the cost of energy, instead of billing for a fixed amount every month.

Smart metering is a major development in utility industries in today's world especially the electrical industries. However, many advantages of smart metering have not been fully explored yet due to the limited functions of many prepaid meters that have been installed or being used so far in most developing countries. With the widespread use of internet and web-based applications, there is the urgent need to focus on how prepaid meters can be aided to stay online through Mobile Communication Systems available in most developing countries.

1.2 LITERATURE SURVEY

Naveen Kumar (2016) proposed an Energy Meter that deals with the measurement of line voltage, phase current, neutral current, computation of active power, and energy being consumed by a consumer and display the information to the consumer and then send the data about the power and energy being consumed to the service provider, identify theft and cut the line for a period of time when the voltage and current exceed specific limits that are already set so that no equipment fails. The service provider can monitor power and energy usage of individual consumer and of specific area in real time. Future scope of the project is that the proposed system can be implemented more efficiently using RTOS, auto cutting of power supply to the consumer in case bill is due, and online billing can be more additions to the system.

Shreedhar A Joshi et al (2016) proposed a smart energy meter which has a unit measuring meter. This device will be in turn connected to the main server with the help of IoT. The algorithm is such that, at the end of each month the device will generate the rate of units and send it to the user's smartphone along with the bill. The android application which will be connected to the same server where the smart meter is connected. The smart meter will be installed by the energy supplier at no charge to you. The cost of the roll out is covered already in the energy bill the same way that installation and maintenance of traditional meters. The wide range of application makes smart energy meters to be used in all the private and public

sectors. The usage of energy meters will reduce power consumption. This saving in power can be effectively used in other areas, where there is scarcity of electricity.

Engidaw Abel (2017) proposed a design of smart electric energy meter based on Arduino Uno microcontroller and SIM900A GSM modem. The developed energy meter measures the energy consumed by the customer, logs it into the SD card every two minutes and sends the energy reading to the remote utility billing station on request. It has also a capability to remotely disconnect the customer line when the bill is not paid in due time and restores it when it is paid. The developed prototype has been tested under specified working conditions and calibration of the results has been made by comparing the voltage and current readings of the energy meter with that of the multimeter. According to the test results, when a utility operator sends a reading request to the energy meter, the energy meter sends energy reading in kWh with the respective customer number to the billing station. The billing station can also connect and disconnect the power line to the customer when required.

Amrita Singh et al (2018) proposed a system designed to eliminate human involvement in the electricity system. IOT (Internet of things) is the network of physical things with electronics software, sensors, and connectivity to enable objects to collect and exchange data. IOT based automatic meter reading is the technology of automatically collecting data energy meters and transferring data to the server for the billing process and if there is any tempering then also detectable. This will help for the proper and accurate reading of the billing process. An attempt has been made to make a practical model of 'IoT Based Smart Energy Meter'. The propagated model is used to calculate the energy consumption of the household, and even make the energy unit reading to be easy and accurate. Hence it reduces the wastage of energy and brings awareness among all. Even it will deduct the manual intervention.

Md Redwanul Islam et al (2019) proposed an IoT based real-time low-cost Smart Energy Meter monitoring system using android application that aims to reduce manual efforts for measuring the electricity units and make users concern about the excessive usage of electricity. Arduino Uno and an optical sensor are used to fetch the pulse of the electric meter. Through this system, customers can easily view total pulse, total units and total costs of electricity. The system is easily readable and reliable. The data stored in the cloud has great importance in future energy meter data mining. In a large sense, energy distribution

companies such as DPDC are able to observe the pattern of consumption of an area. Consequently, this observation can help in load distribution in a certain area.

Patrick Mapulane (2019) proposed a smart energy meter for automatic metering and billing system. The proposed energy meter system (EMS) transmits data like consumed energy in kWh and generates a bill over a GSM mobile network. Some of the research aims were met, for instance, to allow the meter to be able to send messages to a mobile-phone and to allow for remote access, this was enabled by the Arduino GSM shield 2. Problems were experienced with the microcontroller having fewer ports than anticipated. The system also depended for 3G sim cards which are no longer in use. These sim-cards have been faced out in Botswana. The only resort was to change the SIM800A GSM module to GSM shield 2 which allowed for the use of 4G sim cards.

Geno Peter et al (2020) proposed a system that aims to enhance an existing conventional energy meter integrated with prepaid system and protection system. The designed prepaid meter consists of an Arduino, conventional energy meter, GSM module, current sensor and relay. The proposed prototype comprises two parts: GSM technology and overcurrent protection, whereas GSM technology is used for communication and reloads; overcurrent protection is done with a current sensor and relay working together. The GSM technology is directly implemented into the energy meter which is quite innovative. The objective is to enhance the existing energy meter into a prepaid system by using GSM technology. It is cheaper in terms of initial cost, but it suffers from the meter accuracy, human error and billing experience. In this project, the prototype of the smart meter is integrating the GSM prepaid system and the overcurrent protection relay.

Shishir Muralidhara et al (2020) proposed the design and implementation of an Internet of Things (IoT) enabled, minimalistic, cost-effective and efficient smart energy meter which will aid consumers in obtaining information on the energy consumption of any electrical appliance. The idea behind this paper is to implement such an energy monitoring system through which the consumer can be equipped with information of the energy expenditure of individual or multiple electrical appliances. During the testing of the system, it was found to be capable of extracting energy expenditure information, which is then relayed to the ThingSpeak channel. Furthermore, as the consumers are equipped with their consumption

behavioral data, they can consciously reduce their energy consumption and hence, minimize energy expenditure.

Apoorva et al (2020) proposed a system that mainly focuses on automatic billing, power card facility, theft detection, power optimization and providing the relevant energy consumption information to users. The main objective of the proposed work is to develop a smart energy meter. This paper mainly focuses on automatic billing, power card facility, theft detection, power optimization and providing the relevant energy consumption information to the user. In the proposed work, IoT based meter reading system is used to continuously monitor the meter reading, current energy consumption, theft detection and service provider can disconnect the power source whenever the consumer does not pay the monthly bill.

Nsilulu T. Mbungu et al (2020) proposed a dynamic energy management system for a microgrid connected to a grid for residential application. The system models a smart metering system to collect data from different components of the electrical system. It was observed that the formulated strategies provide a better energy gain to the consumer. The closed-loop scheme provided an outstanding performance of the dynamic model due to the profile of the state of charge of the battery with a negative value of cost gain. The model predictive control offered an excellent improvement in the context of energy-saving as compared to both linear strategies with a lower state of charge of the energy storage that can be fixed by the system constraints.

1.3 SCOPE OF THE PROJECT

An attempt has been made to make a practical model of 'IoT Based Smart Energy Meter'. The propagated model is used to calculate the energy consumption of the household, and even make the energy unit reading to be handy. Hence it reduces the wastage of energy and brings awareness among all. Even it will deduct the manual intervention.

1.4 OBJECTIVE

The objectives of the proposed work are as follows:

- To reduce the waste of energy and limit the consumption.
- To regularly monitor the amount of energy the user is consuming.
- To get regular updates & notification of power usage in webpage.
- To make the job easier for both power suppliers & the consumers.
- To design and implement the smart energy meter system in houses and in many public places.

1.5 ADVANTAGES OF PROPOSED SYSTEM

- Auto Cut Off can be done from the main power supply without a person coming from the EB department.
- Electrical & Electronics objects can be controlled from the user's end.
- Web Page is accessible both in Mobile & Computers.
- Bank account linking can be done with our energy metre.
- EB billing can be done for the changing Rules of the Government.
- Users can monitor the meter readings regularly.

CHAPTER 2

PROJECT DESCRIPTION

2.1 BLOCK DIAGRAM AND EXPLANATION OF EXISTING MODEL

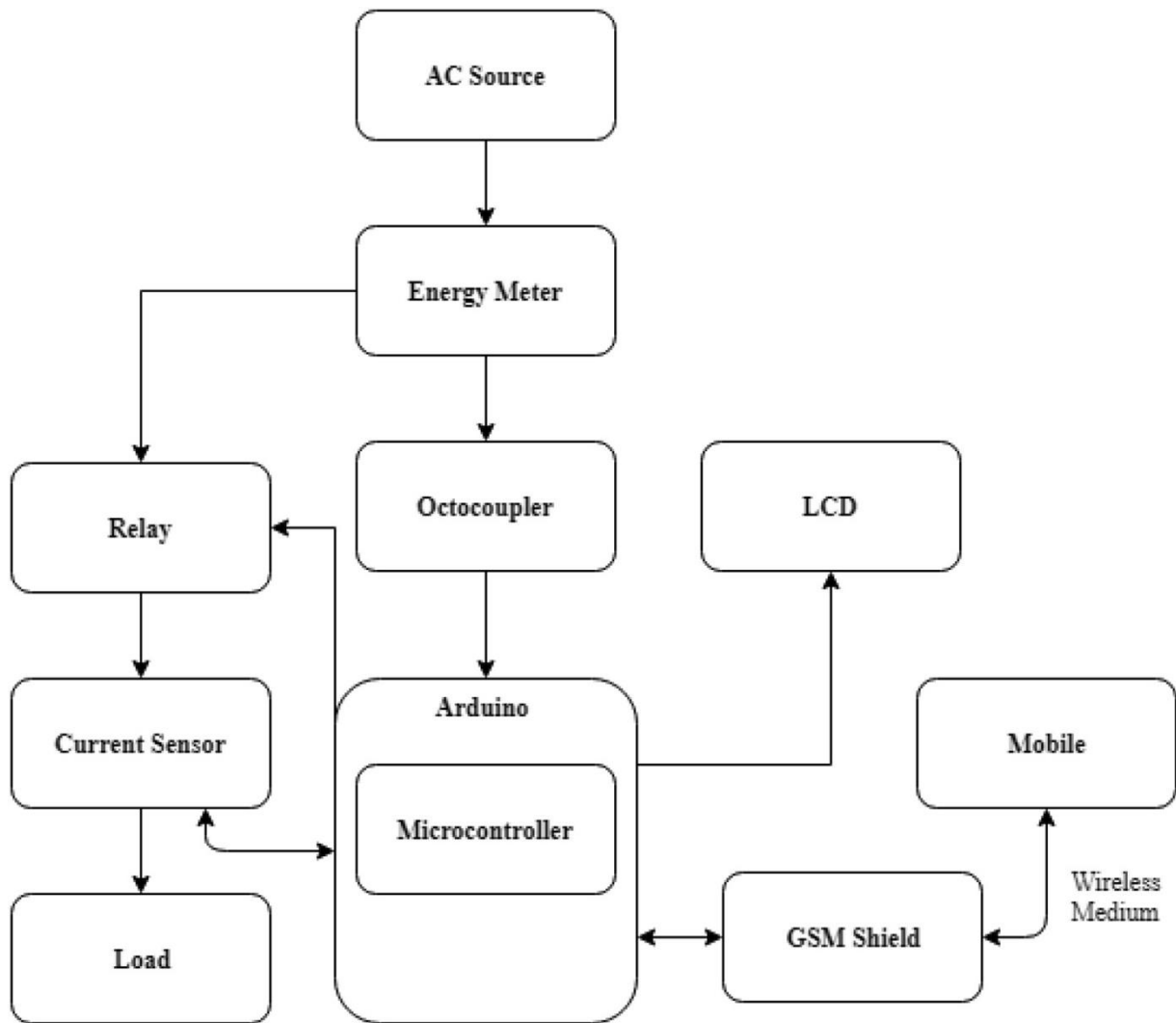


Fig 2.1 Existing block diagram

AC current, which is the main power source, flows directly into the electric energy meter. The energy unit is calibrated by pulse blink technique by using Optocoupler IC counting and redirecting the pulse to the Arduino microcontroller. The LCD display is connected to the main brain, which is Arduino in this case, to display the messages and credit balance. GSM module is used to send and receive SMS, either sending an alert or notification message or receiving recharge code. The relay is connected to the watt-hour meter with Arduino as the input and load as the output to control the load or to turn it ON/OFF. The current sensor continuously measures the current flow to ensure optimal and stable current flow to the load. If any excessive current is detected, the relay immediately reacts to prevent electricity flow. This can prevent the load from failure and burn due to the overload of current.

2.2 DISADVANTAGES OF THE EXISTING MODEL

- Doesn't have a web page.
- The electronic and electrical components cannot be controlled by the user.
- Doesn't have the additional feature to link the user's bank account.
- Switching energy suppliers becomes difficult and can prove hectic for a consumer.
- The usage data doesn't refresh and reflect as frequently as the proposed system which makes the proposed model more accurate
- The existing model doesn't keep track of the history of records upon changing supplier or location.
- The existing module doesn't track power theft.

2.3 BLOCK DIAGRAM AND EXPLANATION OF PROPOSED MODEL

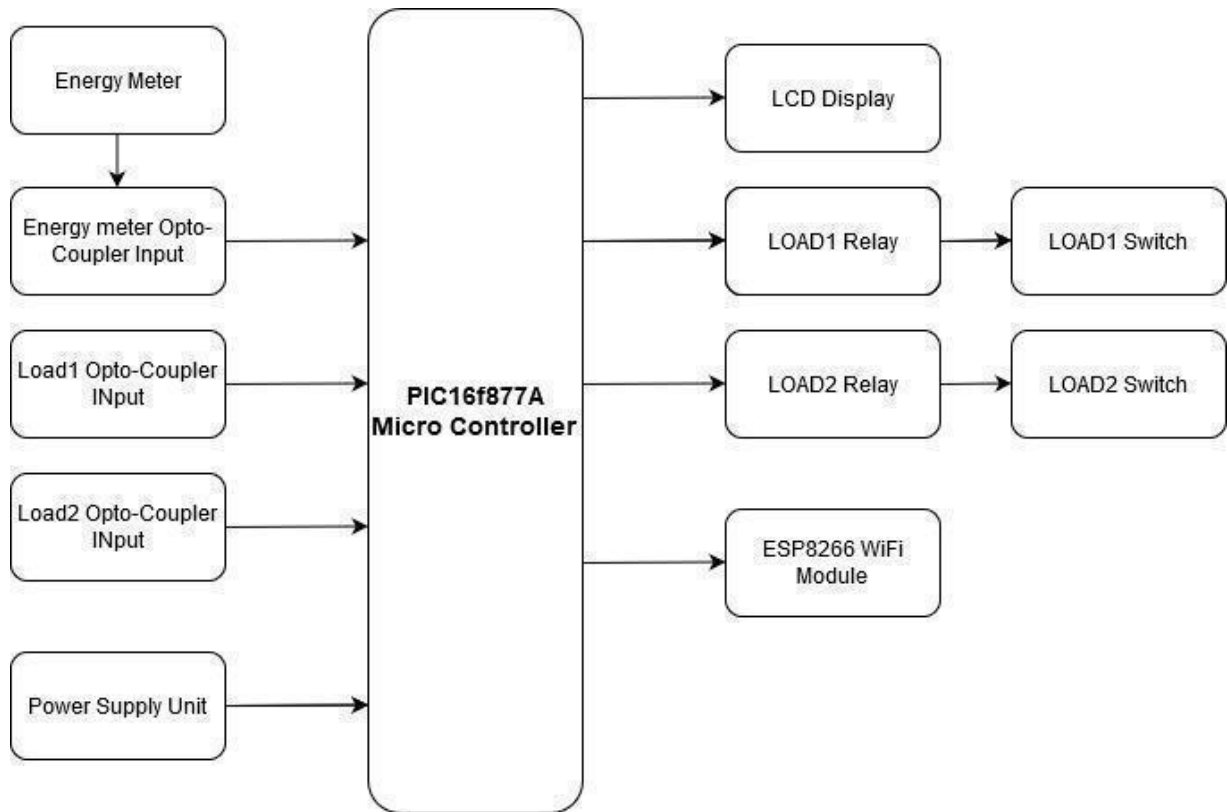


Fig 2.2 Proposed block diagram

When the various appliances of the household consume energy the energy meter reads the reading continuously and this consumed load can be seen on the meter. We can see that the LED on meter continuously blinks which counts the meter reading. Based on the blinking, the units are counted. Normally, 3200 blinks is one unit. In our project we are trying to develop a system in which PIC16f877A acts as the main controller, which continuously monitors the energy meter. As per the blinking of LED on the energy meter the PIC16f877A will measure the unit consumption. The measured reading with the calculation of the cost will be continuously displayed on the web page that we have designed.

Threshold value can be set on a webpage with the help of Wi-Fi, as per the consumer's requirement. When the consumer's reading will be near about to the set threshold value it will send a notification value to the consumer. This threshold value notification will increase the awareness amongst the consumer about their energy usage. When the consumer gets the notification, he can visit the webpage and change the threshold value. If the consumer is not aware of the threshold notification, then the meter will automatically get turned off. Then the consumer has to visit the webpage again and increase the threshold value. By the incrementation, the meter will automatically get turned ON. Finally, the overall monthly bill along with the cost will be sent to customer as well as service provider in the form of text on the very first day of every month.

Energy meter or watt-hour meter is an electrical instrument that measures the amount of electrical energy used by the consumers. Utilities is one of the electrical departments, which install these instruments at every place like homes, industries, organizations, commercial buildings to charge for the electricity consumption by loads such as lights, fans, refrigerators and other home appliances. Energy meters measure the rapid voltage and currents, calculate their product and give instantaneous power. This power is integrated over a time interval, which gives the energy utilized over that time period.

The PIC16f877A board is the heart of our system and hence the entire functioning of the system depends on this board. PIC16f877A reacts to the 5v supply given by opto-coupler and keeps on counting the supply and then calculates the power consumed and also the cost. This data continuously gets stored on the webpage, so that users can visit any time and check their consumption. It even reacts accordingly as per programmed, to situations like message sending during threshold value etc.

Wi-Fi stands for Wireless Fidelity. We are using Wi-Fi which acts as the heart for IoT. Through Wi-Fi the consumer can set changes in threshold value, he can ON and OFF the energy meter. Time to time the readings of units and cost are displayed on a webpage. Consumers can access the PIC16f877A board and meter with the help of Wi-Fi.

2.4 ADVANTAGES OF PROPOSED SYSTEM

- Auto Cut Off can be done from the main power supply without a person coming from the EB department.
- Electrical & Electronics objects can be controlled from the user's end.
- Web Page is accessible both in Mobile & Computers.
- Bank account linking can be done with our energy meter.
- EB billing can be done for the changing Rules of the Government.
- Users can monitor the meter readings regularly.

2.5 FLOWCHART

WEBPAGE FLOWCHART

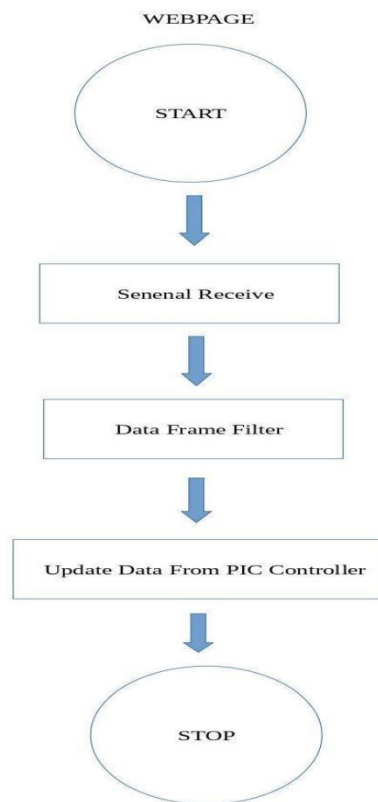


Fig 2.3 Web Page flowchart

All the calculations are done in PIC Controller after writing the code on our IC, it'll send the data to the web page, particularly we're sending the data in serial mode. If we use parallel mode, we'd require a greater number of wires, the data sent are the data of energy meter reading, current value, set value, current date, due date, charge for the energy usage etc.

From serial receiver data are next sent to the DATA FRAME FILTER. This section is used to monitor & filter the unwanted or uncalled raw data, noise, undefined data etc. Here we can give the instruction & it'll only send us the required data and filter the unwanted data out.

2.5.1 *Update Data from PIC Controller:*

In this function we are able to refresh our data. Each function data has separate field values & sent through a serial receiver which will store & display the data field values in web page variables.

Generally, we can also control load 1 and load 2 through the web page and the process will be the vice versa of it, variables sent through the serial receiver & match its field value data.

AUTO CUT OFF FLOWCHART:

Auto cut off operation will be executed under two conditions. First is if the current value is greater than the set value and the other condition is if the current date is equal to the due date. On any occasion if any one of these two conditions is satisfied also auto cut off will be executed.

Auto cut off will be released only if the user pays the amount for his/her electrical usage & if the user wants to turn on/off the connected load then it can be controlled through the web page.

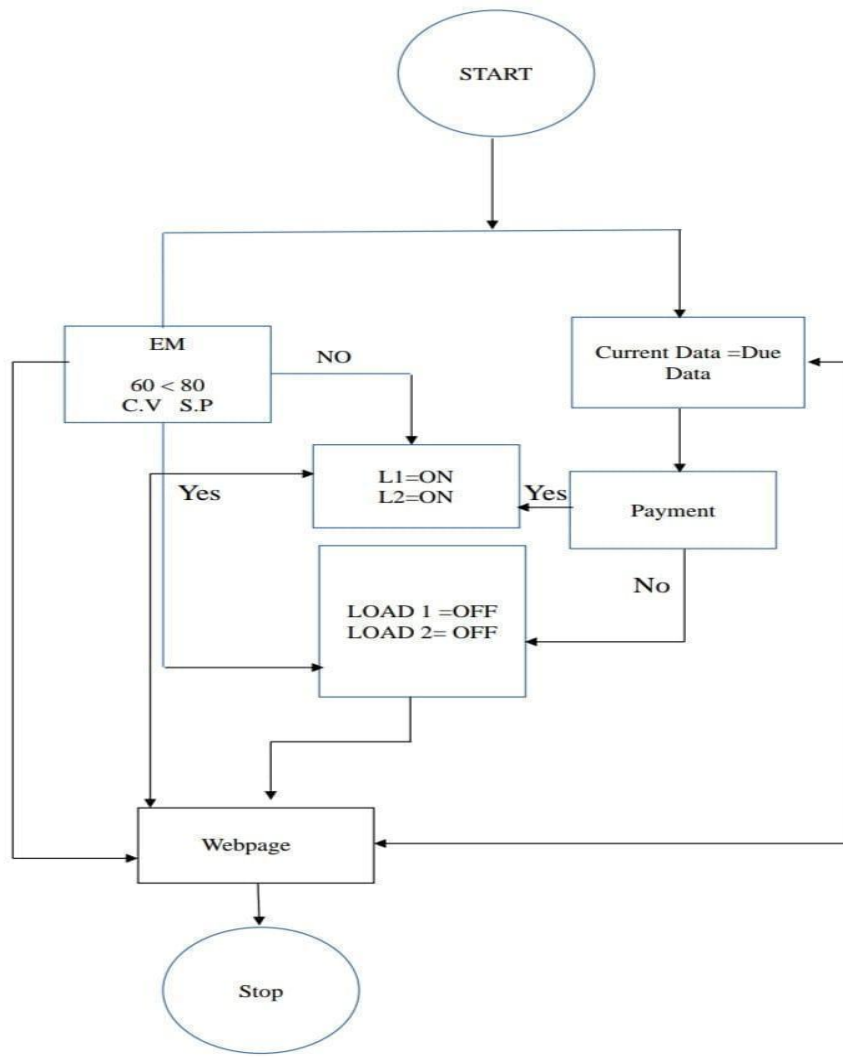


Fig 2.4 Auto Cut-OFF flowchart

CHAPTER 3

Simulation of the Energy Management System

3.1 GENERAL INTRODUCTION ABOUT SIMULATION

Simulation modelling solves real world problems safely and efficiently. It provides an important method of analysis which is easily verified, communicated and understood. Across industries and disciplines, simulation modelling provides valuable solutions by giving clear insights into complex systems.

A simulation is the re-creation of a real-world process in a controlled environment. It uses something called modeling to figure out the result of the simulation. A model is a representation of an object or process that describes and explains a phenomenon when it can't be experienced directly. In science, we come up with lots of rules and laws to describe the world, and those models together allow us to create simulations. For example, we might study the way air molecules move when there is a heat source nearby and create a model to describe it. Then we can put dozens of molecules together and do a simulation.

3.2 ADVANTAGES OF SIMULATION

- It can avoid danger and loss of life.
- Conditions can be varied and outcomes investigated.
- Critical situations can be investigated without risk.
- It is cost effective.
- Simulations can be sped up so behavior can be studied easily over a long period of time.
- Simulations can be slowed down to study behavior more closely.

3.3 SIMULATOR USED FOR THE PROJECT

Here we have used the Embedded C Proteus software for the simulation of our project. Proteus is a complete development platform from product concept to design completion. Its advantages are intelligent principal layout, hybrid circuit simulation and accurate analysis, single-chip software debugging, single-chip and peripheral circuit co-simulation, PCB automatic layout and wiring.

The Proteus software is chosen in this research due to its advantages such as professional PCB layout package, availability of nearly 800 microcontrollers in the library package etc. The developed model successfully measured the energy consumption of several loads and assisted the user in controlling the energy usage through automation control techniques. The accuracy of the results shows that the technique and the model developed in this research can be used by engineers, students and hobbyists who are working with energy monitoring systems and smart home applications directly.

3.4 SIMULATION PROJECT OVERVIEW

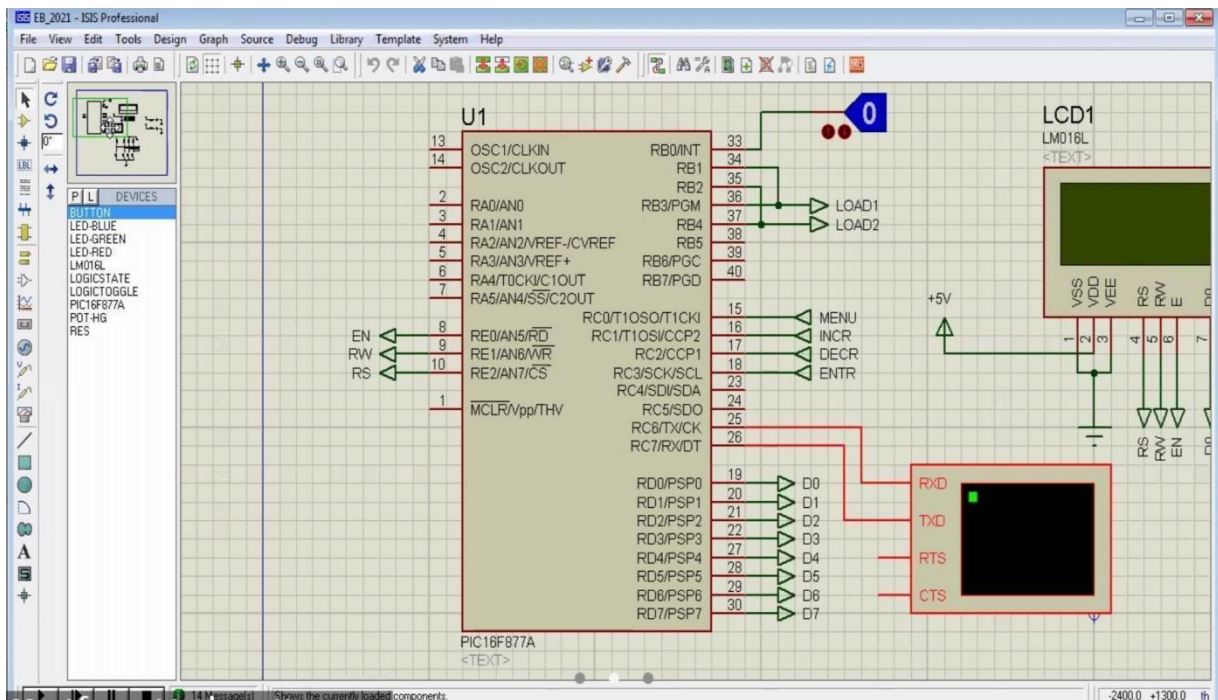


Fig 3.1 PIC16F877A chip

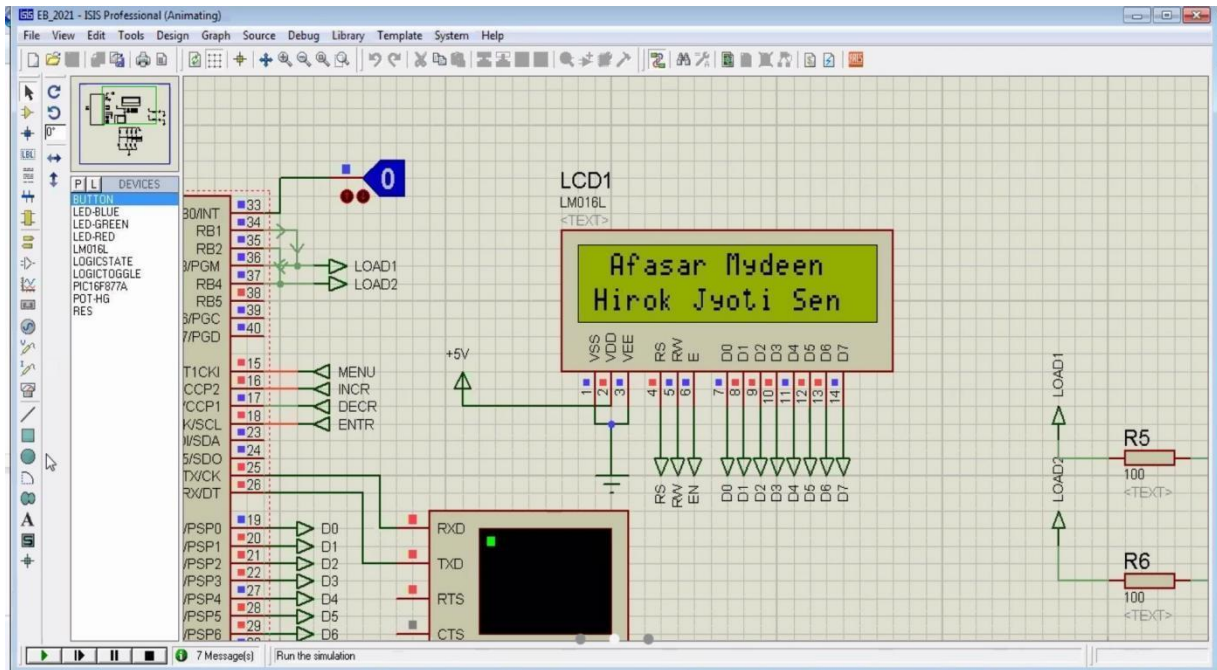


Fig 3.3 LCD

This is an 8-bit LCD which displays all the readings and the notifications which can be seen by the consumer. A user can navigate forward and backward on the screen using the buttons provided.

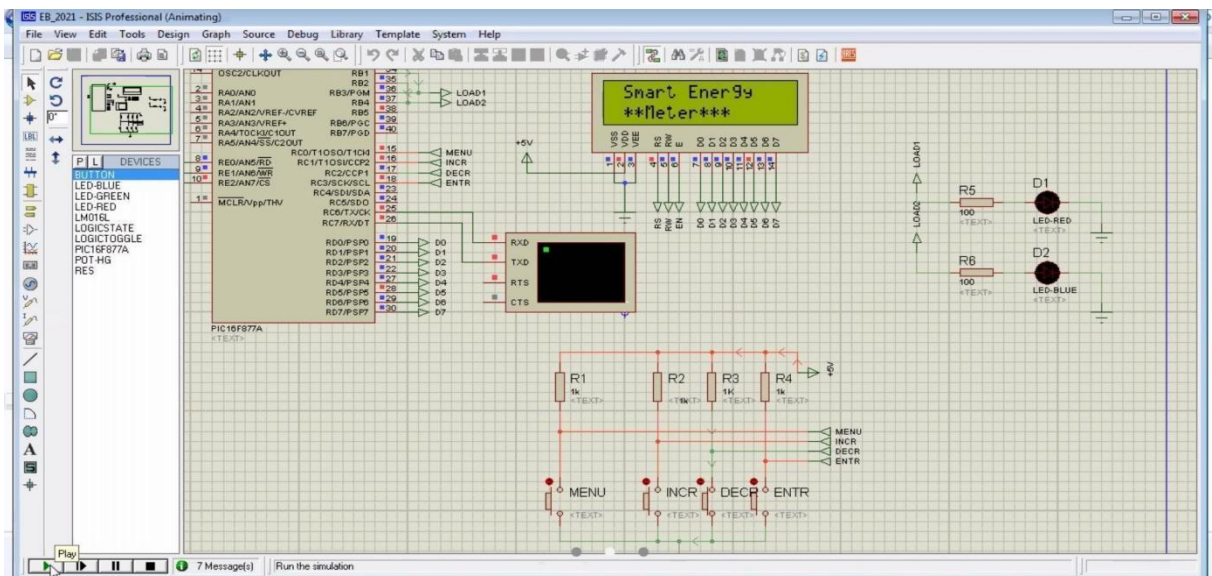


Fig 3.4 Display when the system is ON

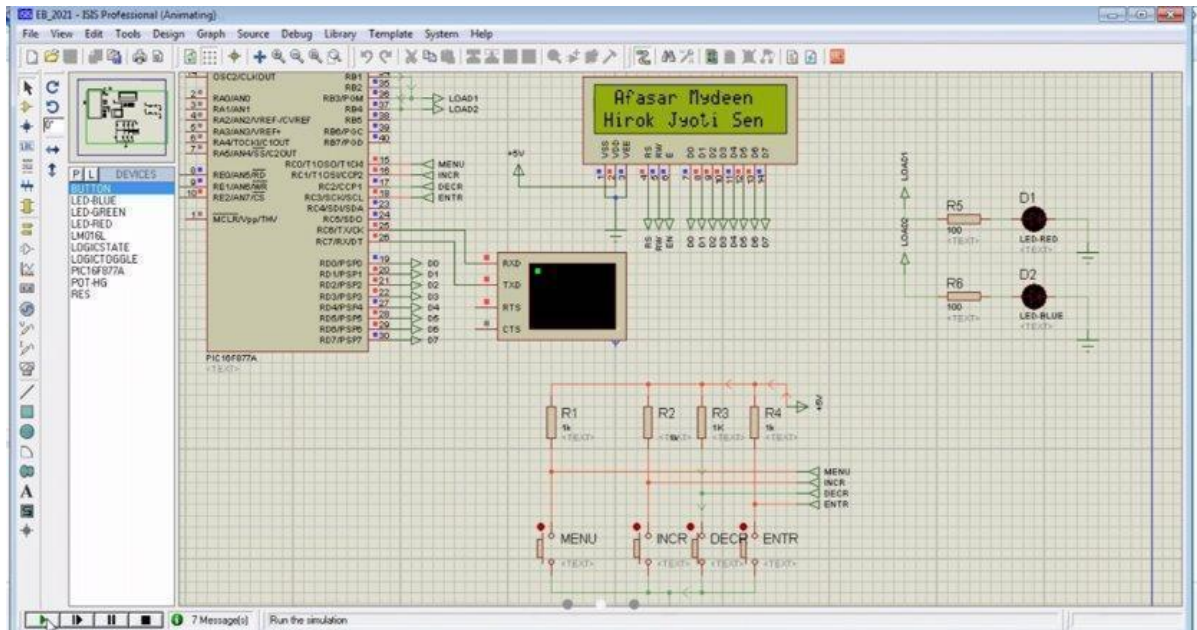


Fig 3.4 & Fig 3.5 shows how the display looks like when the system is turned ON.

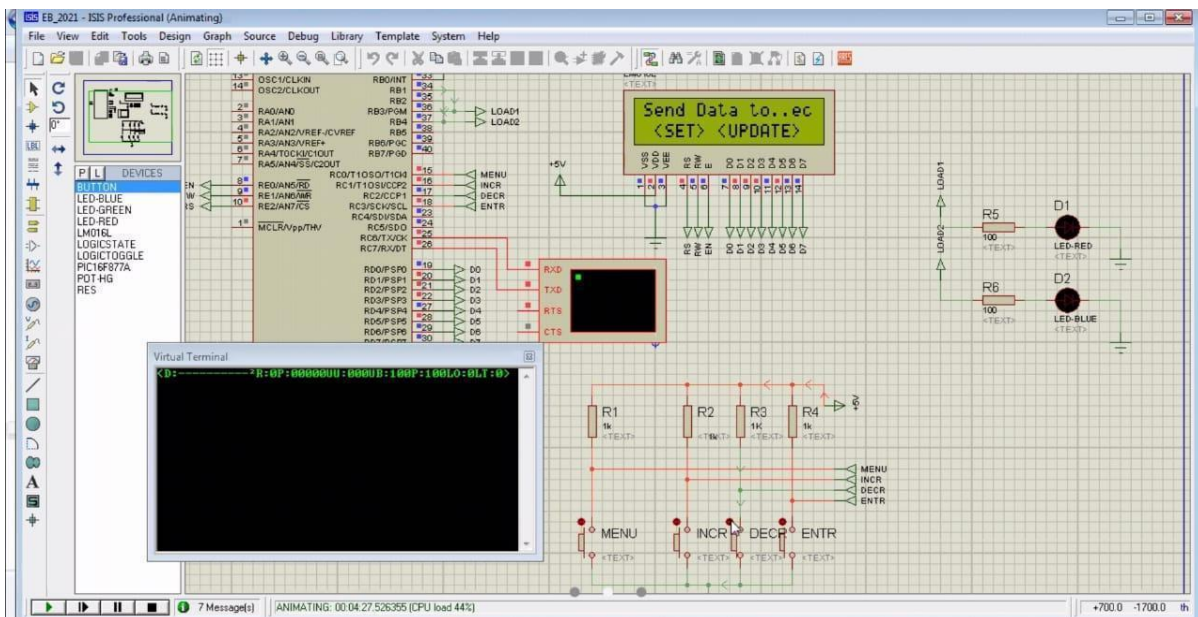


Fig 3.6 Sending the data to Web Page

As the data is updated in the web page automatically at regular intervals, which can be done manually as well hence the user can regularly keep track of their energy usage. Which further helps them limit their excessive energy consumption and also to save the energy which they have been wasting previously. So, the excessive wastage of energy can be controlled as well as the expenses of a user can be limited by certain extent with the use of this device.

3.5 SIMULATION RESULTS

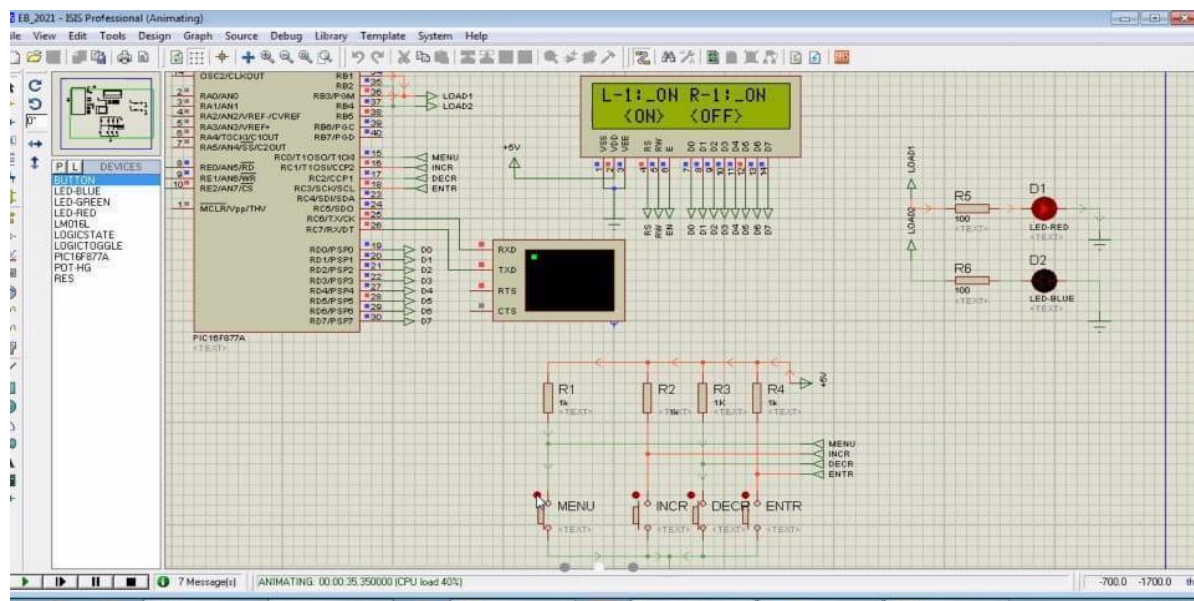


Fig 3.6 The LCD displaying the ON/OFF status of the loads

The ON/OFF status of the loads are displayed on the LCD as well as the web page. These loads can be remotely controlled through the web page which allows the user to turn off the loads even from a distant place in case the user forgets to do so while leaving his house in order to save the energy as well as the user's extra expenses on electricity bill. This is also the result of the simulation carried out to check the performance of the model.

CHAPTER 4

HARDWARE DESCRIPTION

HARDWARE COMPONENTS

4.1 POWER SUPPLY

Power supply is a reference to a source of electrical power. A device or a system that supplies electrical or other types of energy to an output load or group of ical loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones and rarely to others. Circuit diagram is shown in the figure 4.1.

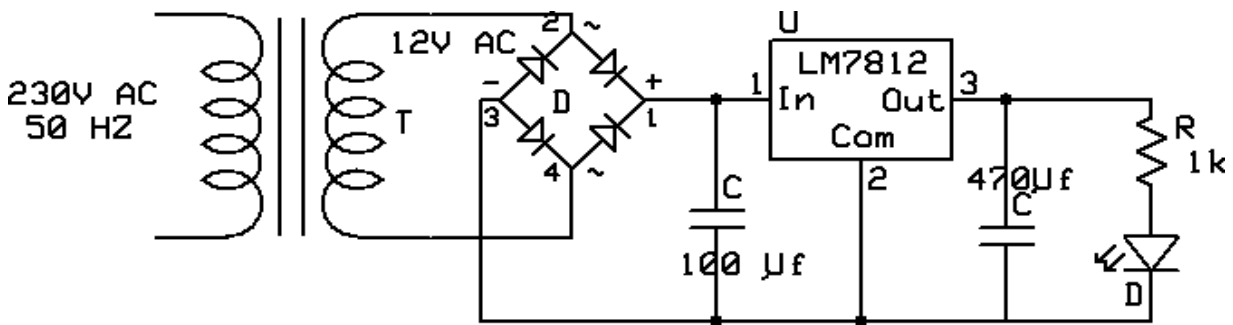


Fig 4.1 Circuit diagram of power supply

A 230V, 50Hz single phase AC supply is given to a step-down transformer to get 12V supply. This voltage is converted to pulsating DC voltage using a Bridge Rectifier. The converted pulsating DC voltage is filtered by a 2200uf capacitor and then given to a 7805-voltage regulator to obtain a constant 5V supply. This 5V is given to all the components in the circuit. A RC time constant circuit is added to discharge all the capacitors quickly. To ensure the power supply a LED is connected for indication purposes.

POWER SUPPLY COMPONENTS

The power supply unit consists of:

1. Bridge rectifier
2. Voltage regulators
3. Filter circuit

4.1.1 BRIDGE RECTIFIER

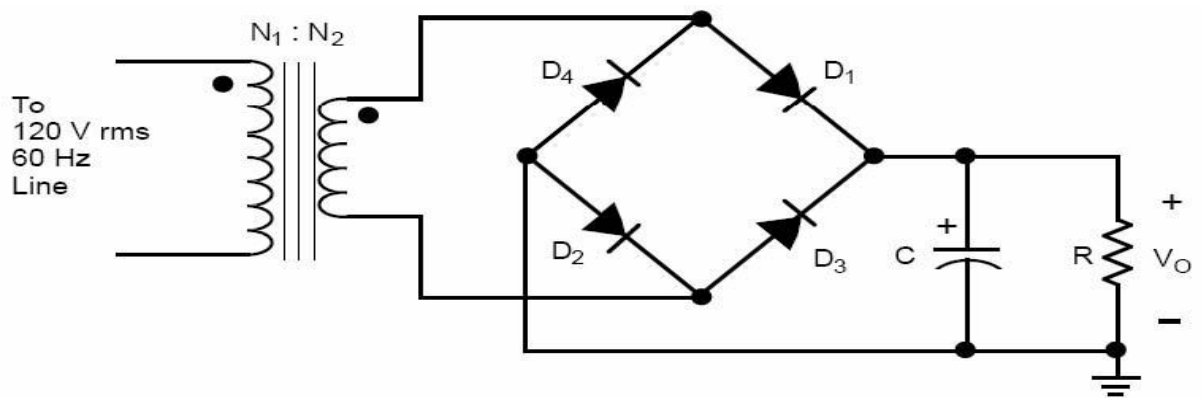


Fig 4.2 Circuit diagram of bridge rectifier

A rectifier is a device which converts A.C. voltage to pulsating D.C. voltage using one or more P-N junction diodes. The P-N junction conducts only in one direction. It conducts when forward biased while practically it does not conduct when reverse biased. Thus, if an alternating voltage is applied across the P-N junction diode, during a positive half cycle the diode will be forward biased and will conduct successfully. While during the negative half cycle it will be reversed biased and will not conduct at all. Thus, the P-N junction diode subjected to an AC voltage acts as a rectifier converting alternating voltage to a pulsating DC voltage.

4.1.2 VOLTAGE REGULATOR

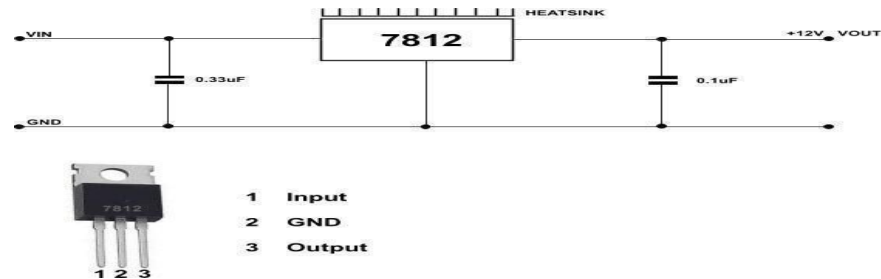


Fig 4.3 Basic circuit design of 78XX series and Monolithic Voltage Regulator

A voltage regulator is an electronic circuit that provides a constant dc voltage independent of the load current and input voltage variations. IC voltage regulators offer the advantages of extremely good regulation, compact size and ease of use.

Here we are using the IC 78xx series of three terminal positive voltage regulators with fixed output voltage making them useful in a wide range of applications. IC 7805 gives a stable +5v supply and IC 7812 provides +12v supply. It employs internal current limiting, thermal shunt down and safe operating area protection, making it essentially indestructible. If an adequate heat sink is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltage and currents.

FEATURES OF VOLTAGE REGULATOR

1. Output current up to 1A
2. Output voltages of 5,6,8,9,10,12,15,18,24 v
3. Thermal overload protection
4. Short circuit protection

4.1.3 FILTER CIRCUIT

ICs are always followed by filter circuits which are usually capacitors acting as a surge arrester. This capacitor is also called as a DC coupling capacitor or bypassing capacitor is used to short the ripple with frequency of 120Hz to ground but leave with the frequency of the DC to appear at the output. The load resistor R is connected so that a reference to the ground is maintained. The load resistor should be 1% to 2.5% of the load.

INPUT SECTION

OMRON PLC CP1E CX programmer is capable of monitoring 24 digital inputs and controlling 16 digital outputs. The PLC used is OMRON CP1E CX programmer. It is capable of monitoring 24 digital inputs and controlling 12 digital outputs. The input which is either given manually or from the field is made available at the input terminals of PLC through the connector. There is a communication port through which interfacing of PC to PLC through RS232 cable is done. Whenever an input signal of +24volt is available at these input terminals, the corresponding input LED on the PLC glows, to indicate its presence.

By means of ladder logics, the output terminal, for the corresponding input terminals are defined. The output signals from O\P 0 to O\P 11 terminals are then given to the auto mode of the SPDT switch, in the output section. To drive a 230-volt A.C load from the PLC, a 230volt supply should be provided to the VAC VDC terminal and corresponding output must be taken from O\P 0 terminal.

OUTPUT SECTION

The output signals from the output terminals of the PLC are given to the auto mode of the SPDT switch. The off mode of the SPDT switch is connected to the relay coil (+) terminal. Therefore for 12 output terminals 12 SPDT switches and 12 relays are provided.

The manual mode of SPDT switch is given a +24volt, to force manually the output to the relay section. The manual mode terminals of all the SPDT switches are interconnected and given a + 24volt supply.

4.2 ULN 2803



Fig 4.4 ULN2803 IC

A ULN2803 is an Integrated Circuit (IC) chip with a High Voltage/High Current Darlington Transistor Array. It allows you to interface TTL signals with higher voltage/current loads. In English, the chip takes low level signals (TTL, CMOS, PMOS, NMOS - which operate at low voltages and low currents) and acts as a relay of sorts itself, switching on or off a higher level signal on the opposite side.

A TTL signal operates from 0-5V, with everything between 0.0 and 0.8V considered "low" or off, and 2.2 to 5.0V being considered "high" or on. The maximum power available on a TTL signal depends on the type, but generally does not exceed 25mw (~5ma @ 5V), so it is not useful for providing power to something like a relay coil. Computers and other electronic devices frequently generate TTL signals. On the output side the ULN2803 is generally rated at 50V/500ma, so it can operate small loads directly.

Alternatively, it is frequently used to power the coil of one or more relays, which in turn allow even higher voltages/currents to be controlled by the low level signal. Pin Configuration is shown in the figure 4.6.

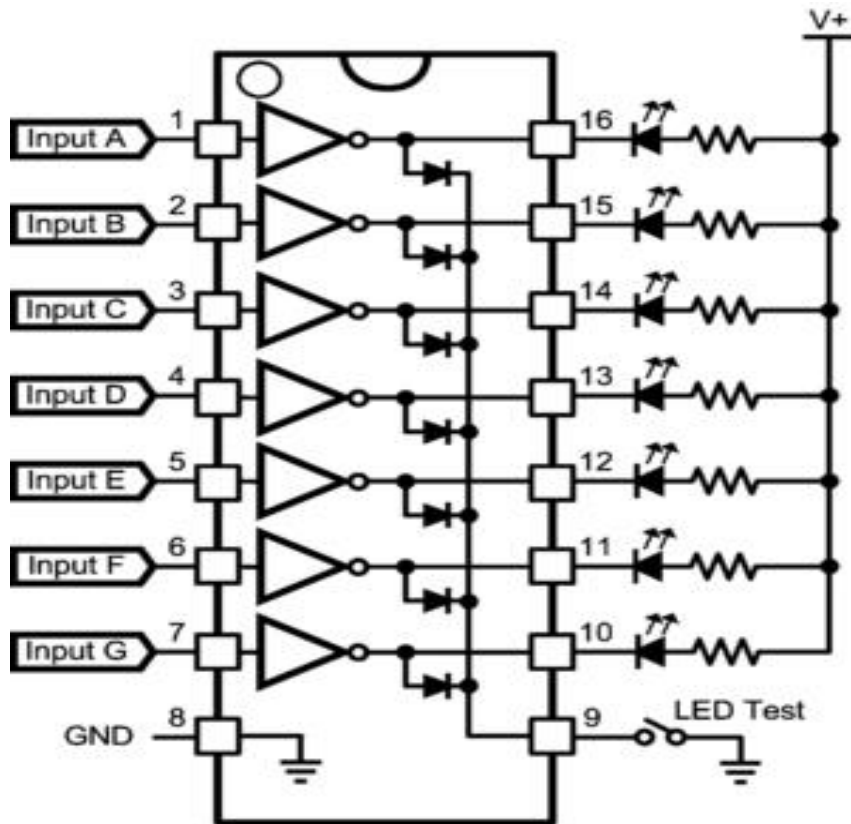


Fig 4.5 Pin configuration of ULN 2803

4.3 IN4007



Fig 4.6 IN4007

These diodes are used to convert AC into DC, these are used as half wave rectifiers or full wave rectifiers. Three points must be kept in mind while using any type of diode.

1. Maximum forward current capacity.
2. Maximum reverse voltage capacity.
3. Maximum forward voltage capacity.

4.4 Microcontroller

The Hardware Kit consists of a PIC16F877A microcontroller. There are totally 10 LED outputs connected to the controller and 3 Potentiometer inputs connected to the controller. The Rx and TX Pin of the Microcontroller is connected to the ESP8266 Wi-Fi module for logging the Data into the cloud. We use ULN2803 to give 12V supply to the LED's to make it glow brighter.

4.5 MENU KEYPAD

4.5.1 GENERAL DESCRIPTION

A miniature keyboard or set of buttons for operating a portable electronic device, telephone, or other equipment it is also possible to use numerous additional modules linked to the development system through the I/O port connectors. Some of these additional modules can operate as stand-alone devices without being connected to the microcontroller.

4.5.2 PRODUCT DESCRIPTION

A keypad is a set of buttons arranged in a block or pad for a specific task. It contains 5 keys arranged in matrix format. The pulses from the microcontroller are used for switching keys in a keypad. In order for the keypad to work properly, pull-down resistors should be placed on the microcontroller's input pins, thus defining the logic state when

no button is pressed.

By combining zeros and ones on the output pins, it is determined which button is pressed. It does not require a separate power supply for switching. The keypad may be used for a multi input switching.



Fig 4.7 Menu Keypad

4.5.3 FEATURES

1. No need of input voltage
2. Multi input switching

4.5.4 APPLICATIONS

1. Switching applications
2. Speed control applications

4.6 RELAY UNIT

4.6.1 DESCRIPTION

This is a high-quality single pole, double throw (SPDT). Use them to switch high voltage, and/or high current devices. The coil voltage on this relay is rated at 12VDC, and the load current is rated up to 10A. Since relays are switches, the terminology applied to switches is also applied to relays; a relay switches one or more poles each of whose contacts can be thrown by energizing the coil in one of three ways:

Normally-open (**NO**) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive.

Normally-closed (**NC**) contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive.

Change-over (**CO**) or double-throw (**DT**) controls two circuits, one normally open contact and one normally-closed contact with a common terminal.

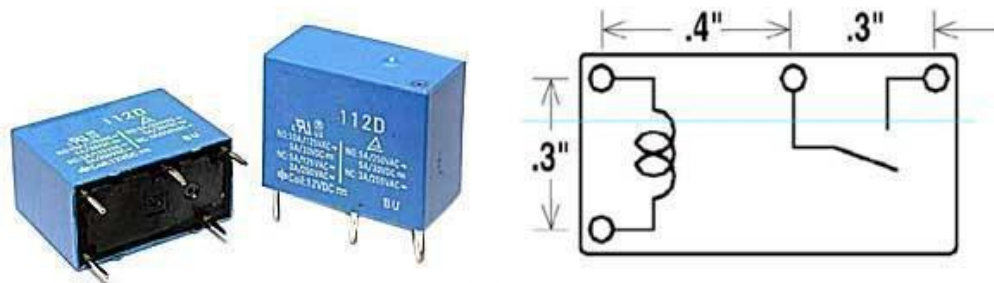


Fig 4.8 Relay diagram

SPST– (Single Pole Single Throw). These have two terminals which can be connected or disconnected. Including two for the coil, such a relay has four terminals in total. It is ambiguous whether the pole is normally open or normally closed. The terminology "SPNO"

and "SPNC" is sometimes used to resolve the ambiguity. The SPST circuit is shown in the Fig 4.9 as follows

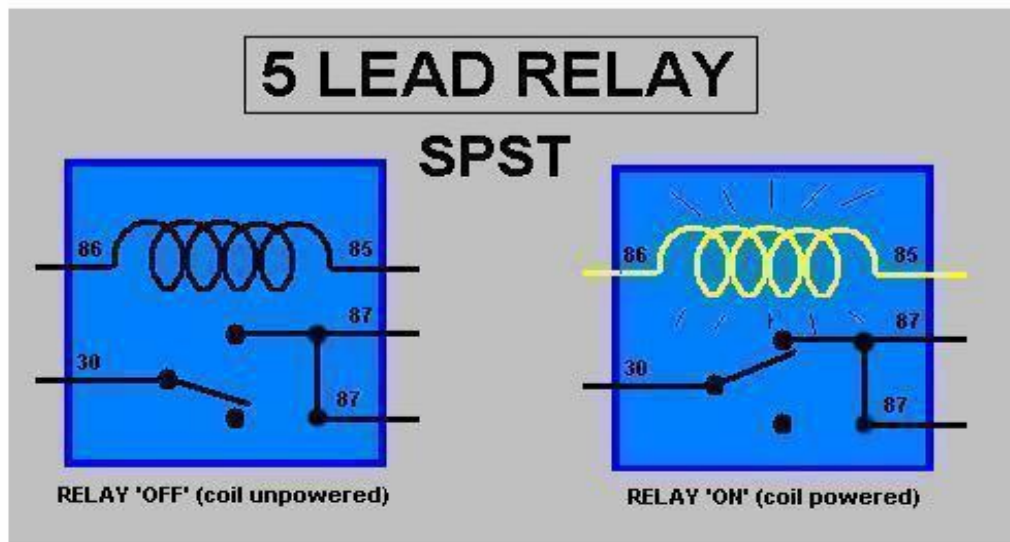


Fig 4.9 SPST circuit

USING SPDT CONTACT OF THE SPST-NO+SPST-NC RELAY

Do not construct a circuit so that over current and burning occur if the NO, NC and SPDT contacts are short-circuited with the SPST-NO+SPST-NC Relay. Arcing may generate short-circuiting between contacts if there is Short-circuiting because of conversion to the MBB contact caused by asynchronous operation of the NO and NC contacts, the interval between the NO and NC contacts is small, or a large current is left open.

4.6.2 SOCKETS

When mounting the Relay, make sure to insert the Relay terminals perpendicularly and correctly into the socket contact pin.

- Hold-down clips (for mounting and removal) are also available.
- The P6C model has a flux-resistant construction. Do not wash it down with water.
- The maximum carry current of sockets is 5A.

4.6.3 FEATURES

1. 12VDC SPDT Relay
2. Rated up to 10A (@125VAC)
3. Fully Sealed
4. Can be mounted directly into the breadboard - 300mil spacing!
5. High Current Contacts
6. RoHS Compliant
7. Compact Size
8. Economically Priced.

4.7 HARDWARE OUTPUT

In the above figure the complete hardware kit can be seen with all the parts included as mentioned in the previous sections, which include the meter, the LCD, the menu keypad, relays etc. And also, the names of the components are mentioned accordingly with each of them. As already mentioned in the previous sections, a transformer is used

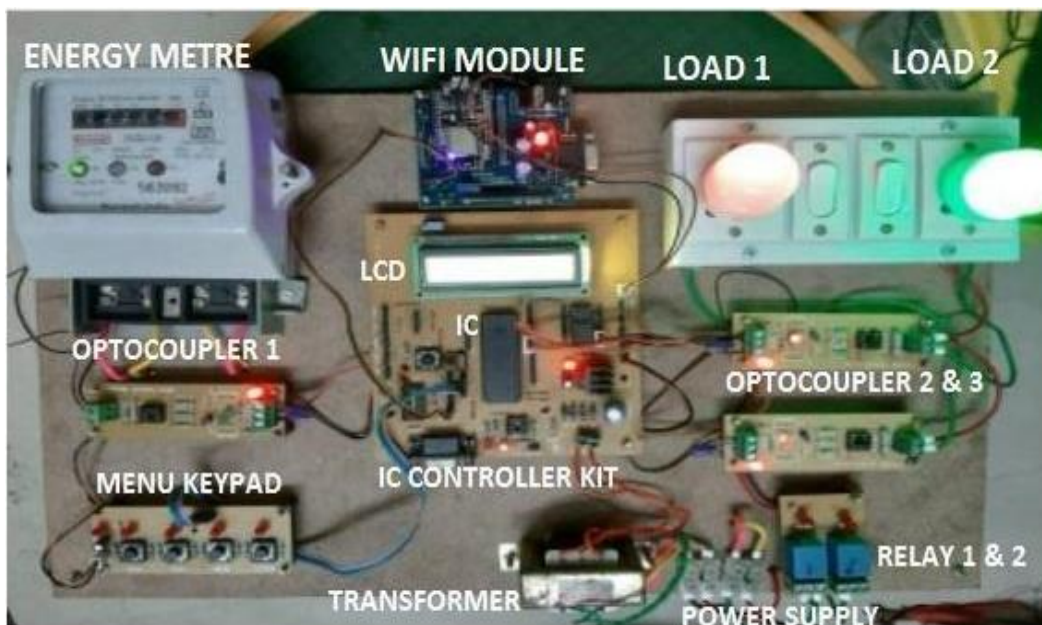


Fig 4.10 Complete Hardware Kit

updating the data in regular intervals. As a result of which the updated data is displayed in the Web Page whenever one needs to check the data.



Fig 4.12 Web Page

The above figure shows the prototype Web Page which reflects all the details regarding the energy usage of a user as well as the status of the loads connected to the system. It shows the due date of the electricity bill, power consumption, amount of power remaining to be used with respect to the usage limit set by the user, amount of bill to be paid as well as the ON/OFF status of the loads which are connected to the particular system. In addition to all these things the Web Page also shows a graphical representation of the exact amount of power consumed on each day of that month, which also helps the user to track down their energy usage on daily basis. And hence they can manage the usage smartly in order to make some savings while paying the electricity bill.

4.8 FINAL OUTPUT

This model gives two different outputs for two different conditions. Whenever one of these two conditions are met, auto cut-off takes place and the supply is cut off automatically without any human intervention. Both the conditions are described below with proper images showing output screens for respective conditions.

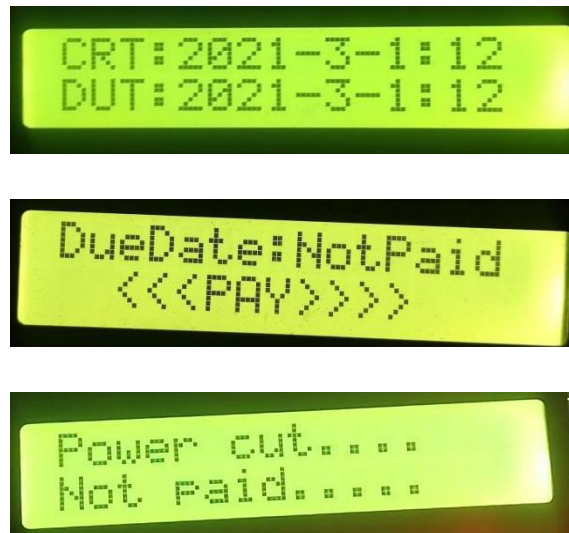


Fig 4.13 Auto Cut-OFF 1 condition

As we can see the figure 4.16 shows multiple screens which indicate the condition for the auto cut-off 1 feature and also how the screen lets the user know, remind them about their pending payment of the electricity bill. The first condition for auto cut-off is that when the current date and the due date are same the power supply is automatically cut off and shall only be released once the bill is paid. Hence there is no manual work to be done in order to cut the supply off. The system gets it done by itself with the help of the already provided input data. As there is no human intervention in between during this process hence there is less or almost no chance of error.

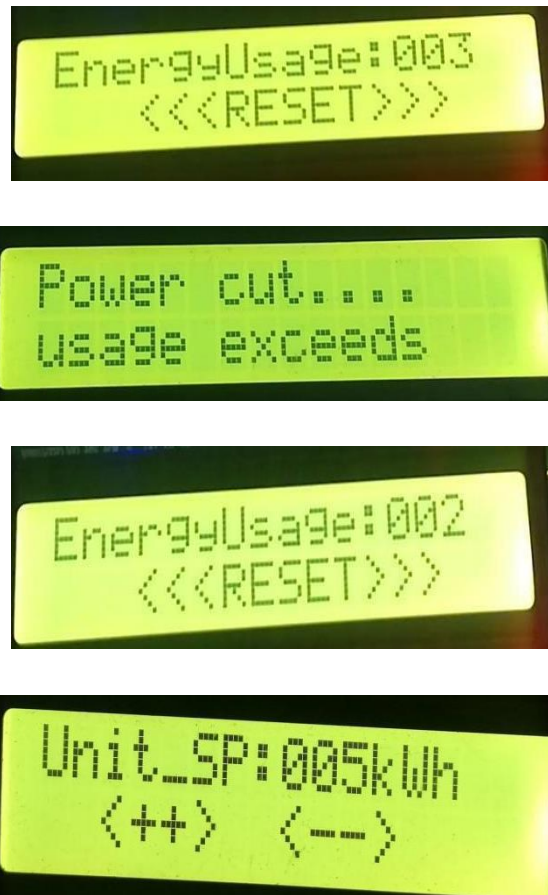


Fig 4.14 Auto Cut-OFF 2 Condition

In the above figure 4.14 we can see multiple screens which indicate the condition for the auto cut-off 2 feature and also how the screen informs the user about the fact that their energy usage has reached the limit set previously and also remind them about their pending payment of the electricity bill. This energy limit can be changed according to one's will and is just a parameter to control or limit the excessive or unnecessary usage which we can also term as wastage of the energy. It is similar to the feature we have in our internet data plans where we can use the data up to a certain limit which is set according to all the different plans available.

CHAPTER 5

CONCLUSION & FUTURE SCOPE

5.1 CONCLUSION

IoT based smart energy meter reading and monitoring system was proposed in this paper. The system provides many significant advantages, such as wireless data transmission, low-workload, remote monitoring and controlling, anti-theft mechanism and less-expenses. The system would provide a simple way to collect the meter reading and detect an electrical power theft without any human involvement. The use of embedded microcontroller and Wi-Fi modules increases the stability of wireless data transmission. By using this system, the customer can anytime check their consumed unit and bill on the Internet in which paper is not required for billing which saves paper and printing costs. The bill can be paid using an online customer support system. In future, the project can be integrated to form smart cities using Internet of Things based sensors as done globally. When compared with the existing GSM based and other traditional energy metering and monitoring system, the proposed system is more efficient and cost effective. It allows the consumer to check the energy consumption and bill any time they login to the system whereas other existing systems send the bill monthly or on request to the customer.

5.2 FUTURE SCOPE

An attempt has been made to make a practical model of 'IoT Based Smart Energy Meter'. The propagated model is used to calculate the energy consumption of the household, and even make the energy unit reading to be handy. Hence it reduces the wastage of energy and brings awareness among all. Even it will deduct the manual intervention.

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